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The Impact of Technological Support on Groups: An Assessment of the Empirical Research

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In this paper we analyze the empirical findings on the impacts of technological support on groups. We define and differentiate two broad technological support systems for group processes: Group Decision Support Systems (GDSS), and Group Communication Support Systems (GCSS). We then present a framework and method for analyzing the impacts of such information systems on groups. We develop the framework from the literature of organization behavior and group psychology and apply it to literature of MIS. We then review the empirical research and findings concerned with the impacts of GDSS and GCSS on groups, and we compare and contrast these findings. Finally, we conclude by discussing the implications of our analysis on the focus of attention and design of future research. Five Major implications stem from our analysis: (1) there is lack of research on some important "formal" factors of groups, (2) there is a paucity of research on the impacts of GDSS and GCSS on the informal dimension of groups, (3) there is a need to move away from laboratory settings to field study in organization settings, with "real" managers, (4) more research is needed on stages of group development and on how they affect the impacts of GDSS and GCSS on groups, and (5) more research is needed to understand how the structure imposed by the technological supports affect group processes.

Keywords: Literature Review, Group Decision Process, Group Decision Support Systems, Electronic Meetings, Group Decision Making.

Introduction

Historically, the study of group meetings has proven to possess both scientific and practical relevance. Scientifically, the study of meetings provides insight into group processes, and the relationship between group cohesion and task performance. Conceptualized as the essence of modern organizations, groups constitute a key basis for acquisition of knowledge on organizations. The practical relevance of these studies stems from the sheer amount of time managers spend in group meetings. Hymowits (1988) reports that managers spend from 25–50% of their total work time in group meetings. With recent advances in com-

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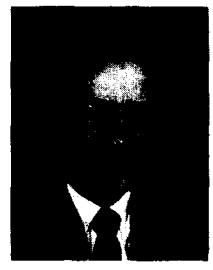

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puters, telecommunication and management science techniques, serious efforts have been made to use technology to enhance group performance. This paper reviews and assesses the empirical research on the impacts of information technology used to support group processes.

This paper has six sections. First we define and differentiate two broad types of technological support systems for group processes: Group Decision Support Systems (GDSS) and Group Communication Support Systems (GCSS). Second we present a framework and method for analyzing the impacts of technological support systems on group processes and outcomes. We develop this framework from systematic review of relevant literature in group psychology and organization behavior. We use this framework to review the empirical research and findings in MIS. Third, we analyze the studies concerned with the impacts of GDSS on groups. Fourth, we analyze the research concerned with the impacts of GCSS on groups. Fifth, we compare and contrast the empirical findings on the impact of GDSS and GCSS on groups. Sixth, we conclude by discussing the implications of our analysis for future research.

Technological Support of Group Processes

Most of the literature concerned with technological support of group processes goes under the label of GDSS. Yet, there is no consensus in the literature on what exactly constitutes a GDSS. Qualitatively different information systems have been included in GDSS. Based on a previous review of existing aids for group decision making (Kraemer and King, 1988), and on other reviews of literature (Benbasat and Nault, 1988; Dennis, George, Jessup, Nunamaker, and Vogel, 1988, DeSanctis and Gallupe, 1987), it seems that there are basically two types of technological supports for groups: Group Communication Support Systems (GCSS) and Group Decision Support Systems (GDSS).

GCSS are information aids. They are systems that primarily support the communication process between group members, even though they might do other things as well. The main purpose of GCSS is to reduce communication barriers in groups. These systems basically provide information control (storage and retrieval of data), representational capabilities (plotting and graph capabilities, large video displays) such as those discussed by Zachary (1986), and group "collaboration support" facilities for idea generation, collection, and compilation such as those discussed by Benbasat and Nault (1988). GCSS also include "Level 1" and "Level 3" supports of DeSanctis and Gallupe (1987) [1]. Examples of GCSS are teleconferencing, electronic mail, electronic boardroom, and local group networks (Kraemer and King, 1988).

GDSS on the other hand are those systems that attempt to structure the group decision process in some way. GDSS can support members' individual decision processes through decision models. This basically corresponds to applying Decision Support Systems (DSS) to groups without supporting the group process per se. Here the technology supports decision processes of individuals working in a group. Examples of such systems are "What if" analyses, PERT, budget allocation models, choice models, analysis and reasoning methods, and judgement refinements such as those discussed by Zachary (1986). GDSS might also be in form of group decision process techniques that support the group decision process itself. Examples of this support are automated Delphi technique, Nominal group technique, information center, decision conference, and collaboration laboratory described by Kraemer and King (1988). This corresponds to "Group 7: Structured Group Decision Techniques" of Benbasat and Nault (1988), and to "Level 2" support of DeSanctis and Gallupe (1987). [2]

[1] Level 1 of the typology of DeSanctis and Gallupe (1987) are technological supports that improve the decision process by facilitating information exchange among members. Examples of Level 1 support are anonymous input of ideas and preferences, and electronic message exchange. Level 3 support its characterized by machine-induced group communication patterns.

[2] DeSanctis and Gallupe (1987) describe Level 2 support of their typology as technological supports that provide decision modeling and group techniques aimed at reducing uncertainty and "noise" that occur in the group's decision process. Examples of Level 2 support are modeling tools, risk analysis, and multiattribute utility methods.

A Framework and Method for the Analysis of Impacts

Framework For Analysis

We develop our framework for analysis from systematic review of research in organization behavior and in group psychology (Mitchell, 1978; Schwartzman, 1986, Steers, 1981; Zander, 1979). Based upon that review, we conceptualize the relationship between technological support and group outcomes as involving four broad sets of factors concerned with: (1) the context, (2) the process, (3) the task-related outcomes, and (4) the group-related outcomes of group interaction. Technological support, which is the focus of this analysis, is a contextual factor along with personal factors, situational factors, structure of the group, and task characteristics.

The broad theoretical notion is that technological support facilitates group process through enhancing group capabilities, removing barriers to group interaction, improving the group in its task, and building or reinforcing the social values of the group to its members through successful task performance. Thus, our framework and much of the MIS research, focuses on identifying the impacts of technological support on group processes while controlling for the effect of the other contextual variables. Group processes in turn influence task related outcomes wich conjointly with group processes, affect group related outcomes. Each of these sets of variables is discussed next.

Contextual Variables

Contextual variables refer to factors in the immediate environment of the group rather than in the broader organizational environment. Five con-

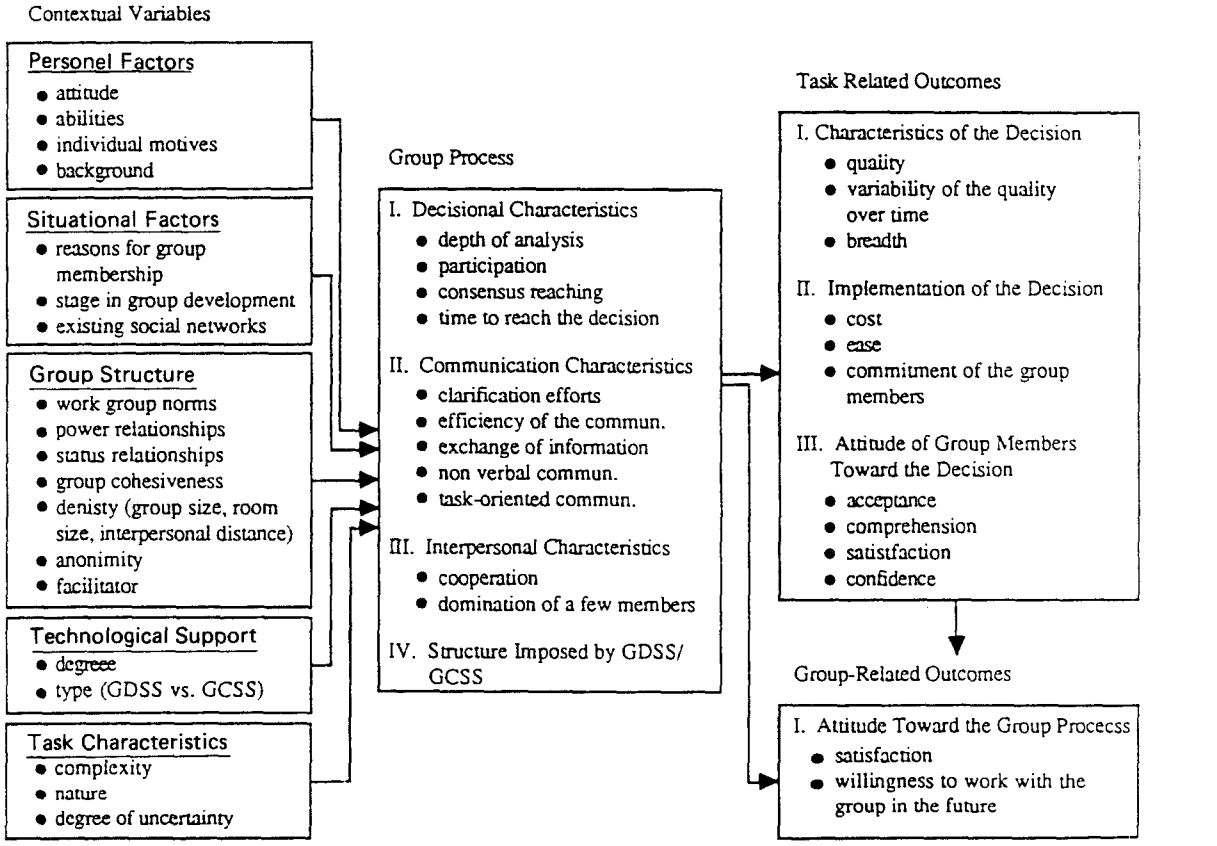

Fig. 1. A Framework for Analyzing the Impacts of GDSS and GCSS on Group Processes and Outcomes. (The framework does not include relationships between independent variables. The framework includes only the most important and relevant variables for GDSS and GCSS studies.)

textual variables appear to be important in the behavioral research on groups: personal factors, situational factors, group structure, technological support, and task characteristics.

Personal factors refer to the attitudes, behaviors, and motives of individual group members. Four personal factors have been found to affect group processes in organization behavior. First is the attitude that group members have toward working in groups and working with the other members of the group. Second is the ability of the members to work in a group. Third is the individual motives, or hidden agendas of group members, and fourth is the background of the group members which includes previous experience in working with groups and other factors like education or specific knowledge.

Situational factors refer to the extent of existing social networks and relationships among members of the group and to the characteristics of the development of the group. There are three main situational factors found to be important in previous research. First are the reasons for group membership,which can be categorized as voluntary reasons (social needs, self-esteem) or involuntary reasons (e.g. superior's request) (Kemp, 1970). Second is the existing social networks between group members, which have a direct impact on the communication and the interpersonal dimensions of group processes (Blau and Scott, 1962; Caudill, 1958). Third is the stage of development of the group. Tuckman (1965) has proposed a model in which groups evolve through four stages: (1) testing and dependence, where group members attempt to understand acceptable and unacceptable behaviors and the norms of the group, (2) intragroup conflict, where members try to establish and solidify their position and also acquire influence over decisions made, (3) development of group cohesion, where members come to accept fellow members and the norms developed, and (4) functional performing, where the efforts of group members become mostly oriented toward task and goal accomplishment.

Group structure refers to patterned relations among members of the group. Five aspects of group structure have been found to influence group process in organization behavior and group psychology research (Cummings and Berger, 1976; Porter and Lawler, 1965): (1) work group norms (Festinger, 1950; Flowers, 1977, Hackman, 1976; Janis, 1972; McGrath, 1964), (2) power relationships (French and Raven, 1968; Mitchell, 1978), (3) status relationships between members (differentiation between the status of members) (Mitchell, 1978; Parson, 1949; Scott, 1967), (4) group cohesiveness (sense of oneness, group spirit) (Cartwright and Zander, 1968; Shaw, 1976), and (5) density of the group, which is a composite factor made of the size of the group, the size of the room, and the interpersonal distance between group members (Cummings and Berger, 1976; Paulus, Annis, Setta, Schkade, and Matthews, 1976; Porter and Lawler, 1965).

Technological support refers to what activities the GDSS and GCSS support and the extent of support they provide. Technological support includes four basic sub-factors. First is the type of support provided, whether it is a GCSS or GDSS, and if it is a GDSS, whether it is a Decision Model or a Group Decision Process Technique. Second, is the degree of support. As stressed by DeSanctis and Gallupe (1987) and Benbasat and Nault (1988), this refers to how through it's structure, capabilities, or technical characteristics the technological support facilitates the generation of alternatives, the choice of alternatives or the negotiation over alternative generation or choice. A third factor is the degree of anonymity the support permits, and a fourth factor is whether a facilitator is part of the support.

Task characteristics refer to attributes of the group's substantive work. Three main factors we found to be important in organization behavior and group psychology. First is the degree of complexity of the task. Second is the nature of the task, e.g. whether it is a financial task or a personnel task (Hofstede, 1968; Janis and Mann, 1977; Mintzberg, Raisinghani, and Theoret, 1976; Pettigrew, 1973). Third is the degree of uncertainty associated with the particular task. For example, in decision making the uncertainty might relate to the consequences of the decision, or to the information provided to make the decision, or both (Bowman, 1958).

Group Process

Group process variables refer to characteristics of the group's interaction, and generally attempt to capture the dynamics of that interaction. We segment group process into three categories: deci-

sional characteristics, communication characteristics, and interpersonal characteristics.

Decisional characteristics basically refer to how decisions are made (Bailey, 1965, Davis, Strasser, Spitzer, and Holt, 1976; Olsen, 1972). This includes the depth of analysis (number of alternatives generated, and number and complexity of criteria used to evaluate these alternatives), the degree of participation of the group members, the degree of consensus reached in making a decision, and the time it takes to reach a decision.

Communication characteristics include the clarification efforts made by group members in trying to understand better the alternatives, the problem or the solution; the exchange of information between members (is there a tendency to withhold information?); non-verbal communication; and the degree of task-oriented communication between members (Argyris, 1975; Delbeq, Van de Ven, and Gustafson, 1975; Van de Ven and Delbeq, 1974).

Interpersonal characteristics include the degree of cooperation in the group (Frenno, 1962; Goldman, Stockbauer, and McAuliffe, 1977; Levit and Benjamin, 1976; Okun and DiVesta, 1975), and the degree to which one or a few members dominate the group processes (Caudill, 1958; Hollander and Julian, 1969; Michener and Burt, 1975; Vroom and Yetton, 1973).

The structure of these group processes (decisional, communication, and interpersonal) is also likely to affect the outcomes of groups. The structure of group processes has two dimensions. First is the degree of structure, or how standardized and stable are the decision, communication, and interpersonal processes. Second is the type of structure, or the extent to which the processes are hierarchically structured, and formal or informal. The structure of group processes is important in MIS research because it is directly affected by technological supports.

Task-Related Outcomes

Task-related outcomes consist of three variables, each of which might be affected by technological support. The first variable is the characteristics of the decision. This includes the decision quality, the variability of the quality of the decision over time (or the consistency of group performance), and the breadth of the decision.

The second task-related outcome variable is the characteristics of decision implementation. This includes the cost of implementation, the ease of implementation, and the commitment of group members to implementation of the decision.

The third task-related outcome is the attitude of the group members toward the decision. This includes the acceptance of the decision by the members, the comprehension of the decision, the satisfaction with the decision, and the confidence in the decision by the group members.

Group Related Outcomes

Group related outcomes include two main variables that might be affected by the technological support. First is the satisfaction of the group members with regard to the process. Second is the willingness of the group members to work in groups in the future, whether in this particular group, or in other groups.

Method Of Analysis

In order to examine what the research says about these foregoing sets of factors, we group the studies by whether they focus on technological supports primarily aimed at reducing noise in *decision* processes (GDSS, table 1) or at reducing communication barriers between members of a group (GCSS, table 2). We characterize further the technological support by specifying whether it is a decision model (support individual decision process) or a group decision process technique (support groups decision process), and whether it supports the generation of alternatives, the choice of alternatives and/or the negotiation over alternative generation or choice. We also characterize the technological supports by the degree of anonimity it permits and by whether a facilitator is part of the support. For each study, we then assess, based on information available in published articles and/or research reports, how each study address the different variables in our framework. We determine what are dependent and independent variables studied, and also what are the contextual variables controlled and not controlled. We do not include all the independent, dependent, and contextual variables addressed in MIS, but only those focused on by several studies and those found to

TABLE 1 EMPIRICAL RESEARCH ON GDSS	CONTEXTUAL VARIABLES						INDEPENDENT VARIABLES																										INTERVENING VARIABLES											DEPENDENT VARIABLES											
	Number of Groups						Personal Factors				Situational Factors			Task Characteristics			Group Structure							Technological Support – GDSS: IDP			GDSS: GDP						DECISION: Decisional Characteristics				PROCESS: Communication Characteristics					Inter-personal Charact.		TASK OUTCOMES: Charact. of the Decision			Implementation of the Decision			GROUP OUTCOMES: Attitude Toward the Decision				Attitude Toward Grp Proc	
AUTHORS (YEAR) (by school of 1st Author at the time of Publication)	Experimental	Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	Attitude	Abilities	Motives	Background	Group Membership	Stage in Group Development	Social Network	Complexity	Nature	Uncertainty	Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance	Generate	Choose	Negotiate	Generate	Choose	Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	Depth of Analysis	Participation	Consensus	Time to Decide	Clarification Efforts	Efficiency of Comm	Exchange of Info	Non-Verbal Comm	Task Comm	Cooperation	Domination by Few	Quality	Quality Variability	Breadth	Cost	Ease	Commitment	Acceptance	Comprehension	Satisfaction	Confidence	Satisfaction	Future Membership
PERCEPTRONICS Steeb & Johnson (81)	5	5	3	complex political crisis	impact of gdss on decision quality	LAB EXP	?	C	?	?	?	1		H	C	H		?			C	?	?				X	X	X	?	C	NC	+		+	+						+		+		+						+	+	+	
SOUTHERN METHODIST UNIVERSITY Gray (83)	4	0	?	4 different decisions		LAB EXP impression	NC	NC	NC	?	NC	2-3	H	M	NC	L		NC	NC	?	NC	?					X	X	X	?	?	?	+								+														
UNIVERSITY OF ARIZONA George et al. (87)			6	sales territories assign-ment	impact of leadership anonymity and gdss	LAB EXP	Cr	Cr	Cr	Cr	Cr	?	Cr	L	C	L	?	X X ? ?									X ? X ?	X ? X ?	X ? X ?	H ? ? H	? ? ? ?	? ? ? ?		+	+	-							-	+											
Nunamaker et al. (87)	7	0	6-22	different strategic planning		Field Study	NC	NC	NC	?	NC	?	?	H	NC	H	?	NC	C	?	NC	C	C				X			H	?	NC		+					+													+		+	
Nunamaker (87)			5			Case study																																															+	+	

TABLE 1 EMPIRICAL RESEARCH ON GDSS (Continued)	CONTEXTUAL VARIABLES						INDEPENDENT VARIABLES																										INTERVENING VARIABLES											DEPENDENT VARIABLES											
	Number of Groups						Personal Factors				Situational Factors			Task Characteristics			Group Structure							Technological Support – GDSS: IDP			GDSS: GDP						DECISION: Decisional Characteristics				PROCESS: Communication Characteristics					Inter-personal Charact.		TASK OUTCOMES: Charact. of the Decision			Implementation of the Decision			GROUP OUTCOMES: Attitude Toward the Decision				Attitude Toward Grp Proc	
AUTHORS (YEAR) (by school of 1st Author at the time of Publication)	Experimental	Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	Attitude	Abilities	Motives	Background	Group Membership	Stage in Group Development	Social Network	Complexity	Nature	Uncertainty	Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance	Generate	Choose	Negotiate	Generate	Choose	Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	Depth of Analysis	Participation	Consensus	Time to Decide	Clarification Efforts	Efficiency of Comm	Exchange of Info	Non-Verbal Comm	Task Comm	Cooperation	Domination by Few	Quality	Quality Variability	Breadth	Cost	Ease	Commitment	Acceptance	Comprehension	Satisfaction	Confidence	Satisfaction	Future Membership
Jessup et al. (88)	5		4	university parking problem	impact of anonony-mity and & proximity	LAB EXP	Cr	Cr	Cr	Cr	Cr	1	L	M	C	L			?	?	C	C					X			H L	C C	?					+																	+	
	5																					C	H L				X			C	C	?					+																	+	
	5																						H L				X			H H	C	?					++																	++	
	5																						H L				X			L L	C C	?							++ ++																
Nunamaker et al. (88)	40	0	3-22	varied		Field Study	NC	NC	NC	NC	NC	?	?	?	NC	?		NC	C	?	NC	?	C				X	X	X	H	NC	NC	+	+		+	- +						-											++ +	
Vogel & Nunamaker (88)	multiple		varied	varied		Multiple	NC	NC	NC	NC	NC	?	?	?	?	?		NC	?	?	C	?	C				X	X	X	?	NC	NC	+	+	+	-													+					+	
OKLAHOMA STATE UNIVERSITY Sharda et al. (88)	16	16	3	upper mgmt	multi pro-duct dec	LAB EXP	C	C	C	C	NC	?	H	M	C	M	NC	NC	NC	NC	C	?	?	X	X	X				?	C	?	o			o					+			+	-								o		
NEW YORK UNIVERSITY Bui & Sivasankran (87) Bui & Al (87)	6	6	3 3	Selecting a regional director		LAB EXP	C	C	C	C	?	1	C	High Low M	C	M	?	?		?	C	?	?				X X	X X	X X	?	NC NC ?	NC				o + -								+ o +										o +	

TABLE 2

EMPIRICAL RESEARCH ON GCSS

AUTHORS (YEAR) (by school of 1st Author at the time of Publication)	CONTEXTUAL VARIABLES: Number of Groups: Experimental	Number of Groups: Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	INDEPENDENT VARIABLES: Personal Factors: Attitude	Abilities	Motives	Background	Situational Factors: Group Membership	Stage in Group Development	Social Network	Task Characteristics: Complexity	Nature	Uncertainty	Group Structure: Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance
UNIVERSITY OF MINNESOTA Gallupe et al. (88)	6 6 gcss	6 6 man	3	marketing case	impact gdss & task difficulty on quality	LAB EXP	Cr Cr	Cr Cr	Cr Cr	Cr Cr	Cr Cr	2-3 2-3	-M -M	high low	C C	M M		? ?	? ?		C C	C C	C C
Zigurs et al. (87)	30 gcss	30 man	3-4	develop admittance criteria & choose	Impact gcss on influence behavior	LAB EXP	Cr	Cr	Cr	Cr	Cr	3-4	H	M	C	M	Cr	Cr	Cr	Cr	C	C	C
Watson et al. (88)	total	82	3-4	resource allocation	impact gcss on behavior	LAB EXP	Cr	Cr	Cr	Cr	Cr	3-4	H	M	C	M	Cr	Cr	Cr	Cr	C	C	C
Poole et al. (88)	total gcss	40 man	3-4	resource allocation	impact of gcss on behavior	LAB EXP	Cr	Cr	Cr	Cr	Cr	3-4	H	M	C	M	Cr	Cr	Cr	Cr	C	C	C
INDIANA UNIVERSITY LeBlanc & Kozar (87)	1	0	?	mgmt of vessel traffic	impact of gcss	Longitudinal case study						4		M		H		?	?	?	?	C	C

AUTHORS (YEAR)	Technological Support: GCSS: Generate	GCSS: Choose	GCSS: Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	INTERVENING VARIABLES: DECISION: Decisional Characteristics: Depth of Analysis	Participation	Consensus	Time to Decide	PROCESS: Communication Characteristics: Clarification Efforts	Efficiency of Comm	Exchange of Info	Non-Verbal Comm	Task Comm	Inter-personal Charact.: Cooperation	Domination by Few	DEPENDENT VARIABLES: TASK OUTCOMES: Charact. of the Decision: Quality	Quality Variability	Breadth	Implementation of the Decision: Cost	Ease	Commitment	GROUP OUTCOMES: Attitude Toward the Decision: Acceptance	Comprehension	Satisfaction	Confidence	Attitude Toward Grp Proc: Satisfaction	Future Membership
UNIVERSITY OF MINNESOTA Gallupe et al. (88)	X X	C C	C C	? ?	NC NC	C C	+ +	o o	- -	+ +						- -		++ +									- -	- -	
Zigurs et al. (87)	X	X	X	?	?	C		+						+				o	o							-			
Watson et al. (88)	X	X	X	?	?	C			o																				
Poole et al. (88)	X	X	X	?	?	C		o	o		o																		
INDIANA UNIVERSITY LeBlanc & Kozar (87)	X	X	X			NC												+											

TABLE 2

EMPIRICAL RESEARCH ON GCSS

(Continued)

AUTHORS (YEAR) (by school of 1st Author at the time of Publication)	CONTEXTUAL VARIABLES: Number of Groups: Experimental	Number of Groups: Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	INDEPENDENT VARIABLES: Personal Factors: Attitude	Abilities	Motives	Background	Situational Factors: Group Membership	Stage in Group Development	Social Network	Task Characteristics: Complexity	Nature	Uncertainty	Group Structure: Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance
CARNEGIE-MELLOW UNIVERSITY Siegel et al. (86) #1	18	0	3	career choice	gcss anonymous & & non anonymous vs f/f	University Settings	Cr Cr	Cr Cr	Cr Cr	C C	Cr Cr	1 1	L L	? ?	? ?	? ?		NC NC			C C	NC NC	NC NC
#2	12	0	3	career choice	simultaneous vs sequential	University Settings	Cr Cr	Cr Cr	Cr Cr	C C	Cr Cr	1 1	L L	? ?	? ?	? ?		NC NC			C C	C C	C C
#3	18	0	3	career choice	simultaneous & email vs f/f	University Settings	Cr Cr	Cr Cr	Cr Cr	C C		1 1		? ?	? ?	? ?		? ?					C C

AUTHORS (YEAR)	Technological Support: GCSS: Generate	GCSS: Choose	GCSS: Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	INTERVENING VARIABLES: DECISION: Decisional Characteristics: Depth of Analysis	Participation	Consensus	Time to Decide	PROCESS: Communication Characteristics: Clarification Efforts	Efficiency of Comm	Exchange of Info	Non-Verbal Comm	Task Comm	Inter-personal Charact.: Cooperation	Domination by Few	DEPENDENT VARIABLES: TASK OUTCOMES: Charact. of the Decision: Quality	Quality Variability	Breadth	Implementation of the Decision: Cost	Ease	Commitment	GROUP OUTCOMES: Attitude Toward the Decision: Acceptance	Comprehension	Satisfaction	Confidence	Attitude Toward Grp Proc: Satisfaction	Future Membership
CARNEGIE-MELLOW UNIVERSITY Siegel et al. (86) #1	X X	X X	X X	H L	C C	? ?	+ +	+ +		+ +		- -	- -		o o	- -	- -												
#2	SI SE	SI SE	SI SE	? ?	C C	? ?				+ +						- -		o o											
#3	S: SE	SI SE	SI SE	? ?		? ?		+ +		+ +					o o	- -													

TABLE 2

EMPIRICAL RESEARCH ON GDSS

(Continued)

AUTHORS (YEAR) (by school of 1st Author at the time of Publication)	CONTEXTUAL VARIABLES: Number of Groups: Experimental	Number of Groups: Control	Size of Group	Type of Decisions	Goal of Research	Research Strategy	INDEPENDENT VARIABLES: Personal Factors: Attitude	Abilities	Motives	Background	Situational Factors: Group Membership	Stage in Group Development	Social Network	Task Characteristics: Complexity	Nature	Uncertainty	Group Structure: Group Norms	Power Relations	Status Relations	Cohesiveness	Group Size	Room Size	Physical Distance	Technological Support: GDSS: Generate	Choose	Negotiate	Anonymity	Facilitator	Structure Imposed on the Process	INTERVENING DECISION: Decisional Characteristics: Depth of Analysis	Participation	Consensus	Time to Decide
NEW JERSEY INSTITUTE OF TECHNOLOGY																																	
Turoff & Hiltz (82) #1	8	8	5	artic survival	impact of gdss on decision quality	LAB EXP	Cr	Cr	Cr	Cr	Cr	1st	L	M	M	H	?	?	?		C	?	NC	X	X	X	?	?	C	+	+	-	+
#2	6	6	5	artic survival	impact of gdss on quality	Field Exp	?	?	?	?	?	1st	L	M	M	H		x	x		C	?	NC	X	X	X	?	?	C			o	
	6	6	5		decision	Field Exp	?	?	?	?	?	1st	L	M	M	H		x	x		C	?	NC	X	X	X	?	?	C			o	
							?	?	?	?	?	1st	L	M	M	H		c	c		C	?	NC	X	X	X	?	?	C			+	
							?	?	?	?	?	1st	L	M	M	H		c	c		C	?	NC	X	X	X	?	?	C			+	

H: High
M: Medium
L: Low
C: Controlled
Cr: Controlled (Random Assignment)
NC: Not Controlled and Possibly Important
Blank: Not Relevant

X: Variable Manipulated
?: Insufficient Data, May be Important

+: Variable Increased
-: Variable Decreased
o: Variable Static

IDP: Individual Decision Process
GDP: Group Decision Process

GDSS: Group Decision Support System
GCSS: Group Communication Support System

Stage in Group Development: 1 = Testing and dependent; 2 = Intragroup conflict; 3 = Development of group cohesion; 4 = Functional role related efforts

VARIABLES: PROCESS: Communication Characteristics: Clarification Efforts	Efficiency of Comm	Exchange of Info	Non-Verbal Comm	Task Comm	Inter-personal Charact.: Cooperation	Domination by Few	DEPENDENT VARIABLES: TASK OUTCOMES: Charact. of the Decision: Quality	Quality Variability	Breadth	Implementation of the Decision: Cost	Ease	Commitment	GROUP OUTCOMES: Attitude Toward the Decision: Acceptance	Comprehension	Satisfaction	Confidence	Attitude Toward Grp Proc: Satisfaction	Future Membership
		-		+		-	o									+		
							+ + +											

be important in the organization behavior or group psychology literature.

Even with these limitations on the scope, our assessment provides a powerful and systematic approach to establish the knowledge cumulated to date. What is known, what is not known, where research efforts should be oriented, and what major threats to validity should be addressed stem clearly from such an analysis. For example, for any dependent variable, like decision quality, we can clearly and rapidly determine: (1) which studies found positive (+), negative (−) and no (0) relationship between technological support and decision quality; (2) whether there is a consensus among the findings of different studies; and (3) whether there are any contextual variables that are not controlled across studies that could offer alternative explanations to the findings.

In a literature review such as this one, the validity of a finding depends less on the quality of any one particular study, than on the diversity of contextual variables controlled and not controlled in the set of studies (Averch, Carroll, Donaldson, Kiesleng, and Pincus, 1972; Salipante, Notz and Bigelow, 1982). Consequently, the more heterogeneous the distribution of uncontrolled contextual variables in a set of studies, the more valid the finding common to the set of studies. Our approach to review the literature then is not as much to discuss each study in detail, but to focus on findings across a set of studies and to discuss the similar and differential impacts of GDSS and GCSS on groups. [3]

Impacts of GDSS on Groups

As shown in fig. 2, the research findings on the impacts of GDSS on groups are consistent both internally (i.e. within a set of variables like group processes, task related outcomes, group related outcomes), and externally (i.e. between sets of variables, such as between group processes findings and task-related findings).

Overall, GDSS affect group processes in three major ways. First, GDSS focus the efforts of group members toward the task, or problem to be solved by the group. GDSS increase the depth of analysis, increase the task-oriented communication, and increase the clarification efforts.

Second, GDSS increase the overall quantity of effort put in the decision process by the group, either by allowing more members to participate and/or the same number of members apply more effort. GDSS were found to increase participation and decrease the domination of the group by one or a few members. This is also consistent with greater clarification efforts caused by GDSS.

Third, GDSS increase consensus reaching. While this appears inconsistent with the previous finding of increased participation, actually it is not. GDSS focus the efforts of the group members on the task to be solved (first finding), and, therefore, greater participation combined with a heightened focus of attention leads to higher consensus reaching.

How these impacts affect decision time is inconsistent. Research shows GDSS to both increase and decrease the time needed to reach a decision. This inconsistency might reflect the fact that GDSS increase participation thereby increasing the needed decision time; however, GDSS focus efforts on the task thereby reducing the need decision time. Depending which variable is more affected, GDSS might increase or decrease the needed decision time.

GDSS were also found to affect task-related outcomes and group related outcomes. GDSS increase the quality of the decision, and the confidence and satisfaction of the group members with the decision. GDSS also increase the group members' satisfaction with the decision process.

By focusing more efforts directly toward the task to be accomplished, GDSS increase the quality of decisions and the confidence and satisfaction of the members with the decision. These effects in turn lead to greater satisfaction of group members with the group processes. Each of these findings are elaborated next in relation to major studies in the field.

Group Process

Depth of Analysis. Five studies focus on the impact of GDSS on the depth of analysis. Steeb and Johnson (1981), Gray (1983), Nunamaker, Applegate and Konsynski (1988), and Vogel and Nunamaker (1988) found a positive impact, while

[3] Readers who want to analyze further each study are encouraged to refer to table 1 and table 2 of this article, and to read Benbasat and Nault (1988) and Dennis, George, Jessup, Nunamaker, & Vogel (1988)

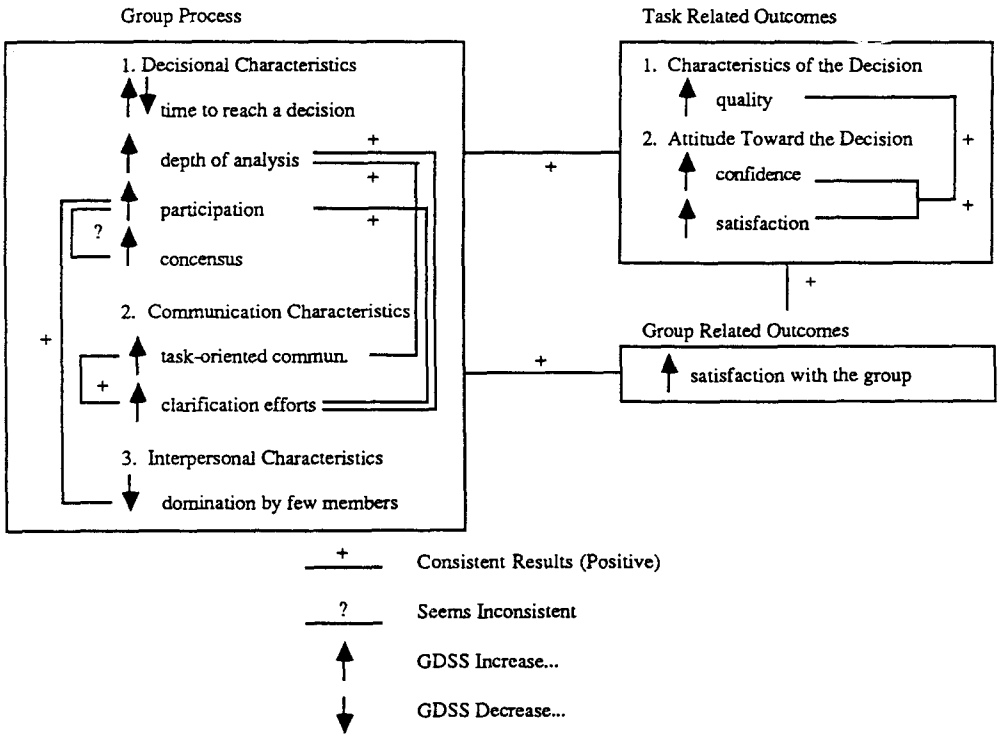

Fig. 2. The Impact of GDSS on Groups.

Sharda, Barr, and McDonnell (1988) found no significant relationship between GDSS and depth of analysis.

Significantly, the type of decision does not appear to affect the positive relationship between GDSS and depth of analysis. This positive impact occurs with decisions ranging from complex political crisis (Steeb and Johnson, 1981) to strategic planning activities (Nunamaker et al. 1988; Vogel and Numamaker, 1988). Moreover, this impact was observed with decision process under varying degrees of uncertainty ranging from very high uncertainty (Steeb and Johnson, 1981) to low uncertainty (Gray, 1983). The validity of this finding is reinforced by its generalized occurrence. The relationship was observed in studies with students (Gray, 1983; Steeb and Johnson, 1981) and with managers performing "real" managerial tasks (Nunamaker et al., 1988). However, it is important to note that the findings with managers are highly impressionistic and not based on controlled experiments.

Sharda et al. (1988) is the only study that did not find a positive relationship between GDSS and the depth of analysis. Unlike the other studies, this study was conducted using a decision model approach, supporting the decision process of individuals working in a group, not the group decision process per se. There seems to exist a synergy which is an important part of the group process; this synergy can be enhanced by supporting the whole group process rather than each individual's decision process.

Task-oriented Communication and Clarification Efforts. Along with an increase in the depth of analysis, research shows that GDSS increase task-oriented communication (Gray, 1983; Sharda et al., 1988) and clarification efforts of group members (Jessup, Tansik, and Laase, 1988; Nunamaker et al., 1988). There are two bases for this conclusion. First, all our studies found a positive relationship; no study obtained counter-findings. Additionally, these findings are consistent with the greater depth of analysis.

Second, these findings seem generalized across multiple studies. The same results were observed with both students (Gray, 1983; Jessup et al., 1988; Sharda et al., 1988) and managers (Nunamaker et al., 1988). Also, groups of varying sizes support the same conclusion [Jessup et al. (1988)

and Sharda et al. (1988) with groups of three or four members, and Nunamaker et al. (1988) with groups ranging from three to twenty-two members. Gray (1983) did not provide this information].

While there is strong support for these findings, there are also notable limitations. Both findings were observed with managerial-planning decisions of medium complexity. Secondly, all four studies focus on the early stages of group development, when members try to establish group norms and typically focus their attention away from the task itself. The benefits of GDSS increasing task-oriented communication and clarification efforts might be minimal at the more advanced stages of group development, when members have already focused on the task. Thirdly, the structure imposed by GDSS on the group processes is not controlled in any study. Consequently, these results might be more indicative of greater structure rather than of technological support itself.

Degree of Participation and Domination by a Few Members. There seems to be an inverse relationship between participation and domination. All studies that found a decrease in the domination structure of groups also found an increase in participation. However, it is unclear which one "causes" the other. It is undetermined whether a decrease in domination incites members to participate more, or by participating more, group members reduce the need and the opportunity for domination.

All four GDSS studies (George, Northcraft, and Nunamaker, 1987; Nunamaker et al., 1987; Nunamaker, Applegate and Konsynski, 1988; Vogel and Nunamaker, 1988) found a positive relationship between GDSS and the degree of participation of group members. Two of these studies also found a negative relationship between GDSS and domination (Nunamaker et al., 1987, 1988).

These findings have three supports. First, all studies found the same relationship between GDSS and participation and domination. These findings are also consistent with an increase in clarification efforts (Jessup et al., 1988; Nunamaker et al., 1988). Second, these findings are valid for groups of varying size. The results were obtained in groups ranging from 3 to 22 members. Third these findings were obtained from both students (George et al., 1987) and managers (Nunamaker et al., 1987, 1988; Vogel and Nunamaker, 1988).

However, there is one serious threat to the validity of these findings, particularly to the increased participation. Most results are impressionistic in nature and were obtained in case studies with no control group (Nunamaker et al., 1987, 1988; Vogel and Nunamaker, 1988). Moreover, the selection of participants of most of these studies might have been biased. The managers who go to a university setting to use its computerized systems are likely to be very motivated, those who are not motivated, do not go. Therefore, it is normal that participation in the group increases. The selection of participants was also often done on a voluntary basis. Therefore, here again it might well be that the study attracted a very specific group of participants (those who enjoy using computer aids). This might positively bias the participation level of the subjects when they are assigned to computer supported groups, and negatively affect their participation when they are not. Therefore, it is plausible that the control group and the experimental group of this study were not really comparable. In other words, participants might be predisposed toward using a computerized system by the mere fact of participating voluntarily in the experiment.

Decision Time. The findings on the impacts of GDSS on decision time are inconsistent. Bui, Sivasankaran, Fijol, and Woodbury (1987), Nunamaker (1987), Nunamaker et al. (1988), and Vogel and Nunamaker (1988) found a negative relationship; Steeb and Johnson (1981) found a positive relationship; and George et al., (1987) and Sharda et al. (1988) found no relationship.

The finding of a negative relationship between GDSS and decision time is highly impressionistic, and is based on uncontrolled case studies (except Bui et al., 1987). One would expect that because GDSS increase participation, depth of analysis, and clarification efforts, GDSS would also increase the time needed to reach decision. More research is clearly needed in this area.

Consensus Reaching. GDSS were also found to increase consensus reaching. Steeb and Johnson (1981), and Vogel and Nunamaker (1988) found a positive relationship; and George et al. (1987) found no relationship. This finding might seem inconsistent with increased participation and de-

creased domination; one would expect the consensus to decrease as more people voice their opinion and try to have their agenda supported by others. However, the relationship between GDSS and consensus might be explained by the fact that GDSS focus the attention and efforts of group members on task related activities (increase depth of analysis, task-oriented communication, and clarification efforts) and therefore permit greater consensus even with increased participation.

Task Related Outcomes

Decision Quality. Four studies that focus on the quality variable showed GDSS increased the quality of group decision (Bui et al., 1987; George et al., 1987; Sharda et al., 1988; Steeb and Johnson, 1981).

This finding is consistent with the impacts of GDSS on group processes. Also, there is consistency in that all four studies found a positive relationship between GDSS and decision quality. Moreover, an increased quality of decision was obtained in tasks of different complexity and uncertainty [Sharda et al. (1988) focus on task of medium complexity and uncertainty and Steeb and Johnson (1981) focus on tasks of high complexity and uncertainty].

However, the potential weakness of this finding is the lack of control of the structure imposed on the group process by the GDSS. Also, most studies are done on groups of three members, which limits the generality of this finding. Finally, the studies [4] used groups in their early stages of development, when members typically do not focus on the task. The gain from GDSS might be important for such groups, but not for groups in advanced stages, who are already "functional" and task-oriented.

Confidence in Decisions and Satisfaction with Decisions. Consistent with the previously enumerated findings, Steeb and Johnson (1981), and Nunamaker (1987) also found that GDSS increase the confidence of group members in decisions (Sharda et al., 1988 found no effect). Furthermore, Steeb and Johnson (1981), Nunamaker et al., (1987), and Vogel and Nunamaker (1988) found that GDSS increase the satisfaction of group members with the decision. Bui et al. (1987), and George et al. (1987) found no effect.

However, the validity of these positive relationships is questionable. Most results were obtained in case studies and are impressionistic by nature (Nunamaker, 1987, Vogel and Nunamaker, 1988 did not have control groups and did not carefully control variables). Secondly, the results of these studies might be biased by the fact that managers went to a university setting for their meetings. It is very possible that the "mystique" of the university setting made managers "feel better" with their decision. Finally, the sample of participants might be biased favorably toward using computers to make decisions by the mere fact of their coming to such a laboratory (the studies had no way of controlling such effects).

Steeb and Johnson's study was conducted in a controlled laboratory setting. However, they did not control the effect of GDSS on the structure of group processes, which might well be the case of greater confidence and satisfaction with the decision. The selection process itself might also have biased the results in this study.

Group Related Outcomes

Satisfaction with the Group Process. Steeb and Johnson (1981), Nunamaker (1987), Nunamaker et al. (1987, 1988), Jessup et al. (1988), and Vogel and Nunamaker (1988) found that GDSS increase satisfaction with the group process. The increased satisfaction with the group process is consistent with the findings of higher consensus, better decision quality, higher confidence in the decision, higher satisfaction with the decision, and increased participation.

Discussion

Overall, it seems that GDSS research provides relatively consistent findings both within groups of variables (group process, task related outcomes and group related outcomes) and across groups of variables. The research shows that GDSS (1) increase the depth of analysis; (2) increase the task-oriented communication and the clarification efforts; (3) increase the degree of participation and decrease the domination by a few members; (4) increase consensus among members of the group. These impacts seem to increase the quality of decisions which in turn, increase the confidence

[4] George et al. (1987) and Sharda et al. (1988) did not provide information on this; however, from the description of their research, they, like Steeb and Johnson (1981) seem to focus on the very early stages of group development.

and satisfaction of group members towards the decision. Furthermore, the changes in group process and in the task related outcomes increase the satisfaction of group members with the group processes.

However, four points need to be made. First, there is a lack of control for the effect of greater structure on group processes resulting from the technological support in most GDSS studies. This is particularly important because greater structure of the processes might cause changes in the group process variables and in the task- and group-related outcomes, rather than the GDSS. For example, Steeb and Johnson compared groups with no aid other than paper and pencil, with groups using GDSS support that provided computer-aided decision tree analysis. The positive relationship between GDSS and several outcome variables might not be an effect of the technological support, but rather of the greater structure imposed on the group processes by the GDSS. Moreover, different types of GDSS might impose a very different form and degree of structure.

Second, several GDSS studies do not monitor the potential effects of a facilitator (or do not provide enough information to determine if they do). A facilitator might affect group processes and outcomes in two ways: (1) intentionally, by playing an active role in planning, conducting, and facilitating the processes, or (2) unintentionally, by (a) mere presence, which changes the atmosphere or the relationships between group members, or (b) being a good versus bad facilitator (i.e., being able or not being able to provide the information required by the group members). The unintentional effect may be particularly important with student participants. Students may perceive the facilitator as a processor evaluating them, which might influence their behavior.

Thirdly, and as discussed earlier, the selection process of many studies favor "computer prone participants". These participants expect and want to use computer aids, but they also might be favorably biased in their estimate of the capabilities and of the impacts of computer aids on the group processes.

Finally, many GDSS studies focus on the very early stages of group development where group members try to establish and understand the norms of the group, try to define and defend their position, and try to obtain a basis of influence over the decision process. GDSS might have significant effects on groups at the early stages of development because it permits the members to focus more rapidly and intensely on the task itself. In a sense GDSS might decrease the time needed to arrive at the "functional" stage of group processes and therefore permit technologically supported groups to outperform nonsupported groups. However, the vast majority of business meetings are composed of people who know each other very well and are used to working together in groups. Therefore most groups are at the later stages of group development, for which the current findings cannot be extended. Research is clearly needed on the relationship between technological support and the stages of group development.

Impacts of GCSS on Groups

We now turn to examine the research on Communication Support Systems in relation to groups. As discussed earlier, GCSS focus on information aids rather than decision models per se. They primarily support the communication process between group members. As shown in fig. 3, GCSS were found to have numerous impacts on group processes and outcomes, most of which are consistent with one another. However, as we will discuss later, several impacts are different from the impacts of GDSS.

Research shows that GCSS affect group processes in four major ways. GCSS increase the depth of analysis; GCSS increase the total effort put in by the group members. GCSS increase participation of group members and decrease domination of the group by a few members. Consistent with greater participation, GCSS also decrease overall cooperation and consensus reaching. It appears that the increase in participation is not all channeled toward the task but also toward political behaviors. Finally, consistent with the previously listed impacts, research shows that GCSS supported groups take longer to reach a decision.

Research also shows that GCSS increase the quality of decisions. While GCSS increase the quality of the decision, they were surprisingly found to decrease the confidence of group members in the decision, and to decrease their satisfaction with the process. This might be related to

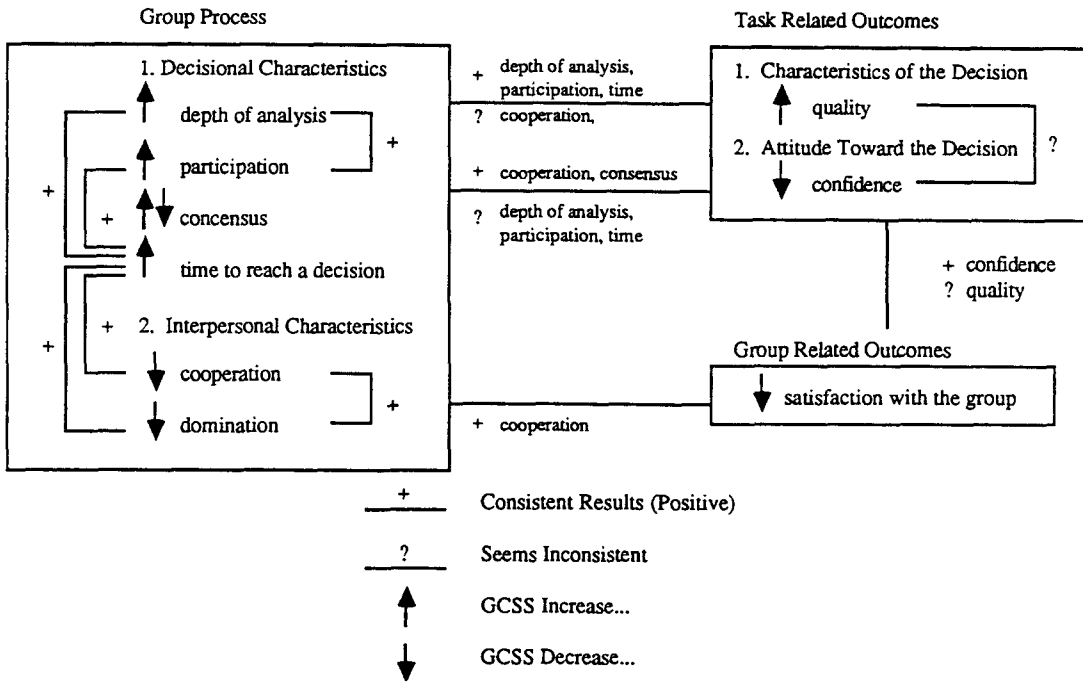

Fig. 3. The impact of GCSS on Groups.

decreased cooperation among group members. GCSS may be efficient in terms of increasing performance of the groups (formal aspect) but not in terms of the interpersonal characteristics of groups (informal aspect). Each of these findings are elaborated next in relation to major studies in the field.

Group Process

Depth of Analysis. Turoff and Hiltz (1982), Siegel, Dubrovsky, Kiesler, and McGuire (1986), and Gallupe, Dickson and DeSanctis (1988) found a positive relationship between GCSS and depth of analysis. Interestingly, this finding was obtained in diverse types of decisions (arctic survival problem and career choice problem), and therefore, it does not seem to be dependent on the type of problem. Although all studies focused on problems of medium complexity, Gallupe et al. (1988) found no difference between high and low complexity problems; therefore, this should not affect the generality of this finding. Alternative explanations were well controlled in this set of studies. At least three studies (Gallupe et al., 1988; and Turoff and Hiltz, 1982) controlled the degree of structure imposed by the GCSS, and the potential impacts of a facilitator was controlled in one study (Siegel et al., 1986). However, results were identical in all these studies; apparently the facilitator did not have a critical impact on the relationship between GCSS and the depth of analysis.

It is important to note that the positive relationship between GCSS and the depth of analysis was obtained with groups in the very early stages of group development. GCSS might permit groups at this stage to increase their focus on the task, or, in other words, to arrive at a functional stage faster than those not supported. However, the impact might be different in groups of more advanced stages of development. Consequently, the finding is not generalized across groups of varying levels of development.

Participation and Domination. Turoff and Hiltz (1982), Siegel et al. (1986), and Zigurs, Poole, and DeSanctis (1987) found that GCSS increase participation. Gallupe et al. (1988), and Poole, Holmes, and DeSanctis (1988) found that GCSS have no effect on the degree of participation of group members. Consistent with the positive finding, Turoff and Hiltz (1982), and Siegel et al. (1986) also found that GCSS decrease the domina-

tion by one or a few members of groups. Zigurs et al. (1987) and Watson, DeSanctis, and Poole (1988) found no relationship.

These two findings are valid for a wide variety of decisions. Also, they are consistent with one another, and with the findings that GCSS decrease consensus and increase the time needed to reach a decision (discussed below).

However, it appears that these findings might also be limited to early stages of development. With the exception of Zigurs et al. (1987), the three studies that found a positive relationship between GCSS and participation focused on groups that were in early stages of development (Siegel et al., 1986, Turoff and Hiltz, 1982. The studies that found no change, focused on groups that were in advanced stages of development (Poole et al., 1988, Gallupe et al. 1988).

This pattern also fits the findings on the dominance in groups. The studies that found negative relationship between GCSS and domination by a few members (Siegel et al., 1986; Turoff and Hiltz, 1982) focused on groups in early stages of development; the studies that found no relationship (Watson et al., 1988; Zigurs et al., 1987) focused on groups in later stages of development. This difference might reflect the fact that the change in the participation pattern and in the structure of dominance is possible only at the beginning of group formation, but not later, when the pattern of participation and the structure dominance is already established. GCSS do not make dominant groups or individuals "powerless", but seem able to prevent their emergence at later stages of group development, if they did not already emerge in the early stages.

Consensus and Cooperation. Gallupe et al. (1988) and Turoff and Hiltz (1982) found that GCSS decrease consensus, while Poole et al. (1988), and Watson et al. (1988) found no impact. Turoff and Hiltz (1982), when incorporating a feedback capability to the GCSS, found a positive relationship between GCSS and the consensus of group members. Two studies (Gallupe et al., 1988; Siegel et al., 1986) found GCSS to decrease cooperation. Poole et al. (1988) found no significant effect.

The research findings appear inconsistent with regard to the impact of GCSS on consensus and on cooperation. However, this inconsistency may be explained by the development factor. The studies that found a negative impact of GCSS on consensus and cooperation focused on groups in early stages of development, and those that found no relationship focused at later stages of group development. This suggests that GCSS reinforce the existing structure of the group. When applied in early stages of group development, when the efforts of the members are oriented toward establishing position, and power over the decision process, GCSS decrease consensus and cooperation. On the other hand, when applied in latter stages of group development, where there is an existing group structure and where the efforts of the members are mainly task-oriented, GCSS do not affect the consensus and cooperation between members.

Decision Time. There is a high consistency throughout the studies on the impact of GCSS on the time groups take to reach decisions. It was found by all studies (Bui and Sivasankaran, 1987; Gallupe, 1988; Siegel et al., 1986; Turoff and Hiltz, 1982) that GCSS increase the decision time. This is consistent with the other findings (increased depth of analysis, decreased consensus and cooperation).

Overall, the finding of the different GCSS studies concerning group processes are quite consistent with one another. The research shows that GCSS increase the depth of analysis, increase participation, decrease the domination by a few members, and decrease cooperation. These changes in the group process apparently cause supported groups to require more decision time.

Task Related Outcomes

Two findings were obtained that seem contradictory to one another. It was found that GCSS increase the quality of decision, but decrease the group members' confidence in their decision.

Decision Confidence. Zigurs et al. (1987), Gallupe et al. (1988), and Watson et al. (1988) found that GCSS decrease the confidence of group members in the decision, and Turoff and Hiltz (1982) found that GCSS increase it. While decreased confidence is consistent with decreased cooperation, it is inconsistent with increased participation, increased depth of analysis, and increased decision quality.

Here again, the studies that found a negative relationship between GCSS and confidence in the decision focused on groups in advanced stages of development; the studies that found a positive relationship focused on groups earlier stages of

development. This suggests that GCSS decrease confidence when groups feel they can handle communication through already existing communication structures. In early stages, GCSS facilitate the focus of efforts on problems and seems to provide a support to the process that is needed. This explanation is supported by the negative relationship found in groups (Gallupe et al., 1988; Watson et al., 1988; Zigurs et al., 1987) with high existing social networks, and a positive relationship (Turoff and Hiltz, 1982), found in groups with low social networks.

Also, the studies that found a negative relationship between GCSS and confidence used problems of medium to low uncertainty whereas Turoff and Hiltz (1982) used problems of high uncertainty. It seems that GCSS help groups that deal with decisions that might have high impacts on the group. As members of the group perceive their decision to have critical impacts on themselves, there is a tendency for the group members to attribute greater responsibility to the computer support.

Quality of the Decision. Turoff and Hiltz (1982) Bui and Sivasankaran, 1987), Leblanc and Kozar (1987), and Gallupe et al. (1988) found that GCSS increase the quality of decision; however, Siegel et al. (1986), and Zigurs et al. (1987) found no relationship.

It is significant to note that even if this finding seems inconsistent with some findings about group processes (like decreased cooperation), it is consistent with most other findings (increased depth of analysis, increased participation, increased time to reach a decision). Also, the positive relationship between GCSS and decision quality seems robust. It was found in very diverse types of decisions, at different stages of group development, and at different levels of task uncertainty and complexity.

Group Related Outcomes

Satisfaction with the Group Process. Bui and Sivasankaran (1987) and Gallupe et al. (1988) found that GCSS decrease satisfaction with the process, while Poole et al. (1988) found GCSS to have no effect.

This negative finding seems to be highly correlated with the degree of cooperation found in groups. Members of groups in which there was a low cooperation, were also found to have a low satisfaction with the process, notwithstanding the quality of the decision. Also, the studies that found a negative relationship between GCSS and satisfaction with the process used groups in early stages of development; studies that found no relationship used groups in later stages of development.

Discussion

Overall, the research on GCSS is consistent. The findings show that GCSS (1) increase the depth of analysis; (2) increase participation and decrease domination by a few members; (3) decrease cooperation; and (4) increase the time groups take to reach a decision. The greater depth of analysis, participation, and the increased decision time seem to increase the quality of decisions. The decrease in cooperation seems to decrease confidence in the decision and satisfaction with the process.

However, five qualifying points need to be made. First, as in the GDSS studies, the selection of participants might bias the results obtained, particularly concerning increased participation. Second, all the GCSS studies (except Turoff and Hiltz, 1982) used students which highly limits the generality of the findings. Third, all studies were conducted with small groups (typically three of four members). There are good reasons to expect that the findings would be different in larger groups. Fourth, Bui and Sivasankaran (1987) and Gallupe et al. (1988) showed that the degree of complexity of the task affects the impact of GCSS on groups. However, most studies on GCSS focused on tasks of medium complexity, and are therefore limited in their generality. Significantly, most studies do not account for the effect of the group's stage of development. This deficiency, although it might not be the only factor, seems to explain numerous apparent inconsistencies in the findings, and also limits the generality of the findings.

The Impacts of GDSS and GCSS: Comparison and Contrast

Our review of empirical research suggests that GDSS and GCSS have similar impacts on some aspects of group processes and outcomes, but opposite impacts on other aspects. GDSS and

GCSS both increase the depth of analysis of groups, increase participation, decrease domination by a few members, and increase decision quality.

On the other hand, GDSS are found to increase consensus reaching, increase confidence in the decision by the group members, increase the satisfaction of group members with the process, and increase the satisfaction of the group members with the decision. GCSS are found to decrease cooperation, increase the time to reach decision, decrease the confidence in decisions, and decrease the satisfaction of the members with the group process.

Our differentiation between GDSS and GCSS clarifies the findings of empirical research that otherwise seem inconsistent (Pinsonneault and Kraemer, 1989). When one analyzes the research without differentiating technological supports, one finds very inconsistent results. There is evidence of increased and decreased confidence in decisions, of satisfaction in decisions, and in the group processes. However, by grouping technological supports as either communication related (GCSS) or decision related (GDSS), the empirical evidences become consistent for each type of technological support. This suggests that GCSS and GDSS provide quite different support to groups and, consequently, have different impacts on them. The common impacts of GDSS and GCSS might be due to the similar support they provide facilitating communication between group members. The differential impacts might be due to the difference in support, GDSS supporting the decision process of groups.

Hence, it seems that GDSS and GCSS, by decreasing the communication barrier between group members, permit groups to channel the efforts of the members towards task-oriented activities and therefore increase the depth of analysis and the decision quality. On the other hand, GDSS, by providing additional support to the group, increase the confidence members have in the decision, and increase their satisfaction with the decision and their satisfaction with the group process, while GCSS decrease these aspects. There are three potential explanations for this difference in impacts.

First, GCSS might not meet the expectations of the participants relative to their view of technological supported group process. This might make them dissatisfied with the process and with the decision, and also decrease their confidence in the decision.

Second, our review of the research shows that when GCSS are applied to groups in early stages of development (when there is no established communication network yet), GCSS increase the confidence of group members in the decision. However, when GCSS are applied to groups at more advanced stages of development (when communication networks are already established), GCSS do not seem to provide any perceived benefits, and consequently the confidence in the decision and the satisfaction with the group process decrease. GDSS on the other hand is perceived by the members as providing additional benefits at all stages of group development. This increases the confidence of the members in the decision, and their satisfaction with the decision and with the group processes.

It is important to note however that both GDSS and GCSS were found to increase the quality of the decision, and therefore the differential impact is in perceived measures. This difference in perception in nonetheless important because, if group members feel that GCSS are not efficient, even harmful, the future of GCSS is threatened.

The third explanation for the difference in impacts is that GDSS focus group processes on the task and facilitate consensus. GCSS, although focussing efforts on the task, increase personally oriented communications. This decreases cooperation and decreases the confidence of group members in the process. It also decreases their satisfaction with the process and with the decision.

Implications for Future Research

This review of empirical findings on the impacts of technological supports on groups has significant implications for both the focus of attention and the design of future research.

Four points concerning the focus of attention of future research stem from our review. First most research effort is focused on a few factors of the formal dimension of group process, like decision quality, decision time, and depth of analysis. There is a lack of research on other important "formal" factors of groups, such as how technological supports affects communication and inter-

personal processes of groups and the impacts of technological support on decision implementation and on group related outcomes.

Second, there is a paucity of research on the impacts of technological support on the informal dimension of the group, like power struggles, status establishment, and hidden agendas. Yet, is argued by Schwartzman (1986) and other behavioral scholars, and as reported in the *The Wall Street Journal* (June 21, 1988), the informal dimension of groups might well be the most important function of meetings.

Third, the level of group development significantly affects how the technological supports affect group processes, yet it is not taken into account in current research. This review shows that GDSS and GCSS have different impacts on groups, depending upon whether they are applied to groups that are early or advanced in their developmental process. This factor, however, is not taken into account in present research, and its effect might have biased findings cumulated to date. More research is needed to better understand the impacts of the development factor on the success of GDSS and GCSS. Research in group psychology shows that important differences in group processes can be expected between groups with and without meaningful history and future.

Fourth, the structure imposed on group processes by the technological supports seems to have important effects on groups, but has not been investigated. This review shows that findings on how GDSS and GCSS affect groups are different whether the structure imposed by the technological support is controlled or not. This suggests that some impacts associated with the technological support are in fact due to greater structure in group processes. More research is needed to clarify the importance of this effect.

One important point on the design of future research stems from our review. Most GCSS studies were conducted with students in university settings. The GDSS studies were conducted with both students (George et al., 1987; Gray, 1983; Jessup et al., 1988; Sharda et al., 1988; Steeb and Johnson, 1981) and managers (Nunamaker, 1987; Nunamaker et al., 1987, 1988; Vogel, 1987; Vogel and Nunamaker, 1988; Vogel et al., 1987) which provides greater external validity to the findings. However the GDSS studies typically lack control over contextual variables and leave open many alternative explanations that the GCSS studies control. Also, all studies, except Leblanc and Kozar (1987) were conducted in laboratory settings. Now that more group technological supports become more widespread and that we have a basic understanding of how GDSS and GCSS affect groups, field studies in real organization settings are needed.

Such field studies mean that researchers will have less control over contextual and independent variables than in laboratory settings. Therefore, they need to carefully identify and report the context in which the study is conducted. For this, table 1 and table 2 can be used as guidelines to the factors to be taken into account. The most important factors that stem from our review are: size of the group, type of the decision, complexity of the decision, group's development stage, reasons of members for joining the group, power and status relationships between group members, group's density, degree of anonymity, structure of group processes, and presence and quality of a facilitator.

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